DOCUMENT RESUME

ED 205 384 SE 035 433

AUTHOR Isaacs, Patricia A.
TITLE Preparation and Validation of a Videotaped Test of Conservation Suitable for Grade 6 Students in Jamaica.
PUB DATE 81
NOTE 18p.: Contains occasional marginal legibility, particularly in the Appendix.

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Cognitive Development: *Cognitive Tests: *Conservation (Concept): *Elementary Education: Elementary School Mathematics: Elementary School Science: Evaluation: *Mathematics Education: *Science Education: *Test Construction: Test Validity

ABSTRACT

Described is the development and validation of a test designed to assess the cognitive levels of Jamaican sixth graders. Instead of the usual clinical procedure, a 30-minute videotaped test was designed in order to standardize variables associated with the test's administration. The film presented situations involving seven conservation concepts including liquid quantity, solid quantity, weight, displaced volume, and horizontality. Following a trial run, the test was administered to 586 urban and rural sixth graders. Reliability and validity were examined through a test-retest procedure, factor analysis, and comparison with the results of a clinical test. The filmed test met the desired criteria. Appended is a description test situation depicted on the videotape. (MB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED205384

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Patricia A. Isaacs

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

PREPARATION AND VALIDATION OF A VIDEOTAPED TEST OF CONSERVATION SUITABLE FOR GRADE 6 STUDENTS IN JAMAICA

PATRICIA A. ISAACS

Science Curriculum Officer
UWI/US-AID Primary Education Project
University of the West Indies, Mona
Kingston 7, Jamaica, W.I.

SE 035 433

The Association of Science Teachers of Jamaica, in cooperation with the Ministry of Education, have for many years been involved in an on-going programme of curriculum construction and revision. In the mid-seventies, work was started on the design of a new integrated science curriculum for Grades 7 to 9 in the New Secondary Schools.(1) Concern arose that concepts were being included at Grade 7, when no evidence existed that the necessary prerequisites had been mastered at the Primary (Elementary) Level.

An attempt was therefore made to determine those concepts and skills that a group of Science Educators in Jamaica felt were essential if students were to be able to benefit from secondary science and maths programmes. A long list of concepts was identified, but it appeared that the conservation concepts were almost unanimously assumed. It was decided therefore that they would form the basis of this investigation, but that one spatial ability concept would be included since the measurement of volume would appear to depend upon it.

The type of test was determined by the following considerations:

a. the limited time available,
b. the need for a reasonably large sample,
c. the low reading/writing levels of the students,
d. the desireability of using local materials and situtations,
e. limited assistance being available,
f. lack of exposure of students to individual testing,
g. the need to standardise the proceedure,
h. the minority race of the tester.

Since Kingsley and Hall (1967) had shown that environmental variables could bias this type of research, it was felt necessary to standardize the procedures. Several researchers had tried different methods of presentation of conservation tests. Balwant Singh (1968) used filmed material, Teates (1970) used slides and tape recordings, while Murray (1970) used a variety of different methods of presentation. None of them found significant differences between the results they obtained by these methods, and those obtained by the method of clinical exploration. Two articles by O'Bryan and Boersma (1972) and Wheatley (1972) reported further validation of filmed presentation of Piagetian tests, while Wheatley suggested that this method tended to screen out distracting stimuli and focused attention on the significant features of the display.

It was felt that a videotaped test would satisfy many of the considerations,

(1) 80 New Secondary Schools have been established since 1968, to provide secondary education to large numbers of students in Grades 7 to 11 who failed to obtain sufficiently high marks on the Common Entrance Examinations to qualify for a place in one of the 44 traditional High Schools.

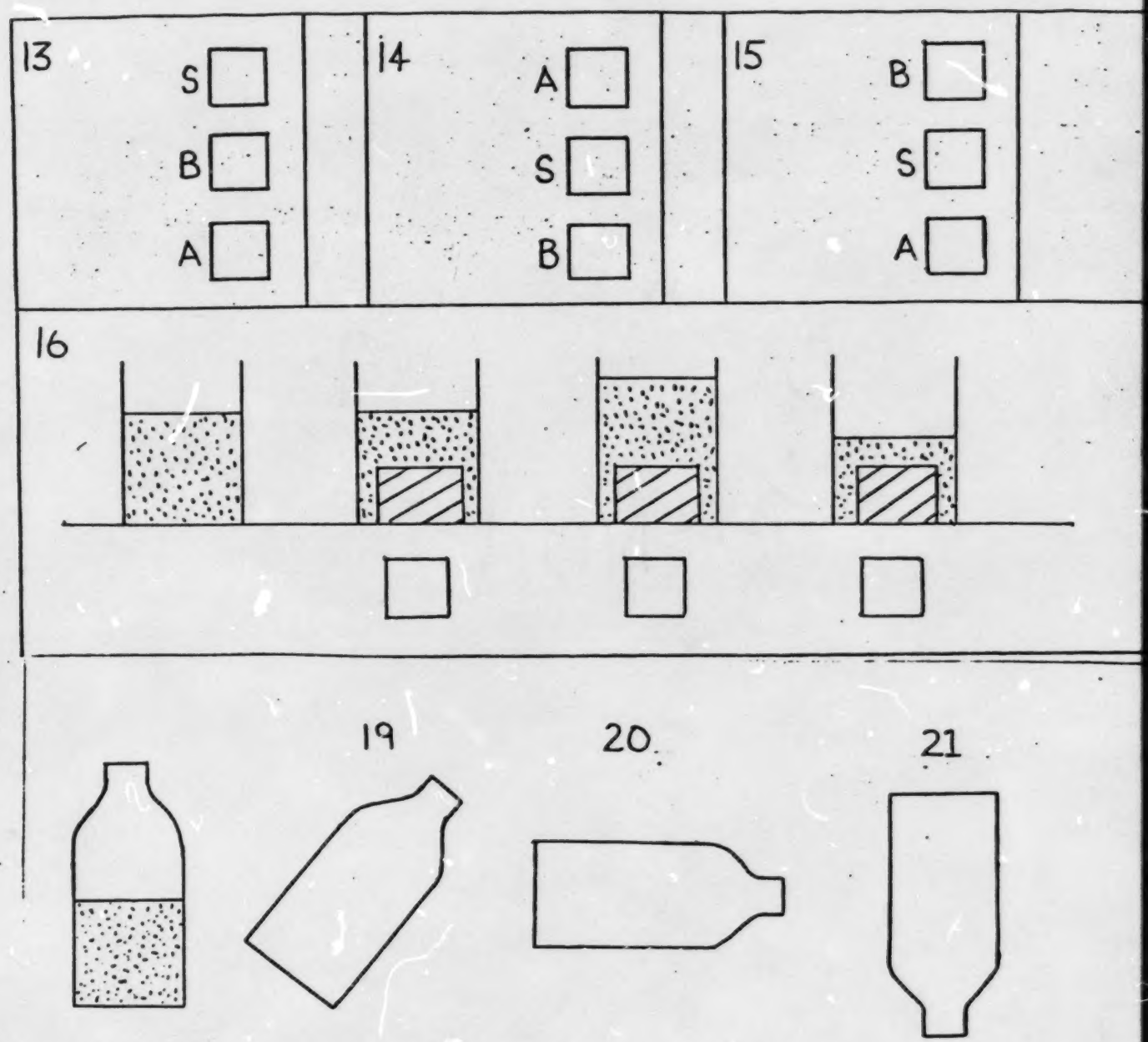
particularly if this could be accompanied by an answer sheet which eliminated the necessity for reading. In making the videotape, a concerted attempt was made to meet the following criteria: 1) it should be comprehensible to all students
2) it should use familiar language, materials and situations,
3) it should be interesting enough to hold the attention of the subjects,
4) it should not last longer than 30 minutes, and
5) the tester should not appear.

In an attempt to produce a test that students would find interesting, the film told the story of a group of young people, aged 10 to 13, who were helping to make preparations for a wedding that was to take place later that day. The actions and materials used were all familiar to the students being tested, for example, length questions involved hair ribbons, area questions evolved from the polishing and laying of tables and internal volume (liquid quantity) involved the fetching of milk and the drinking of Kool Aid. The other concepts under investigation were solid quantity, weight, displaced volume and horizontality. Three questions were asked on each concept, each included in a short scene. The young actors presented three possible answers to each question and the scene ended with possible answers being labelled A, B or S and with the question being redirected to the subjects. The scenes were unscripted but the actors were instructed as to the questions and answers they were to present and the actions they were to perform. They were asked to supply dialogue using the sort of language that they would use at home under similar circumstances. The scenes were filmed individually, viewed and refilmed as necessary. Unfortunately, editing equipment was not available. Care was taken that the testor did not appear, although directing the questions to the students, and only her right hand was visible.

An answer sheet was designed which, for the majority of answers, provided squares labelled A, B and S in one of which the subject was expected to place a check mark. The orders of the letters were changed with each question. Figure 1 shows an example of 3 parts of the answer sheet. The answers to the three questions on displaced volume were shown in diagramatic form, as were the horizontality ones where outlines of the bottles were provided and students were required to draw in the level of the water and to shade in the part of the bottle that was filled.

A trial run of the test was made in a school which draws its students from a nearby low-income housing settlement and from the Polio Rehabilitation Center. A few children of university families also attend the school and it has students of a wide range of mental and physical abilities and disabilities. 38 students in Grade 6 took part in the trial and were asked how they felt other students would enjoy watching the film, and how we could improve it. They made some useful suggestions.

Figure 1 ' Examples from students answer sheet



The film was also viewed by a Creole language specialist who made some comments.

In scoring, one point was given to each correct answer, thus the score for each concept could vary between 0 and 3. Students scoring 0 or 1 were classed as non-conservers. A score of 2 indicated partial conservation, while a conserver answered all three questions correctly.

The results were analysed using chi square and it was immediately obvious that the area questions needed modification. Parallax had seriously affected the appearance of the tables used, and these scenes were remade using smaller tables and an elevated camera. Two of the questions were felt to be in need of slight language modification. Students comments highlighted a lack of familiarity with the type of answer sheet used, and this resulted in the addition of three questions at the beginning of the test. These were on one-to-one correspondence. A blow-up of the top of the answer sheet was made and used with a movable check mark to teach students how to record their answers. The three additional questions were not scored and did not form a part of the study. When the final film was made it lasted just under 30 minutes.

The test was administered to 610 students who were in their final half term in Grades 6, and who were expected to enter Grade 7 in September. A few students were rejected from the sample, largely on account of age or incompleteness of results. The distribution of the final sample of 586 is shown in Table 1. 43% of the sample were boys and 59% were girls. They attended 3 types of schools:

1. Preparatory or Privately run schools for fee-paying pupils,
2. Government Primary Schools for non fee-paying students and terminating in Grade 6, or
3. Government All-Age Schools for non fee-paying students terminating in Grade 9.

A part of the sample lived in the Kingston and St. Andrew urban area. The remainder lived in rural communities chosen because they were of similar size and had similar amenities. It was felt that the diversity between rural communities was likely to be so great as to be a confusing variable, so the aid of the Town Planning department was sought in identifying places which, while being typical rural areas, would also form a group with similar characteristics.

A certain amount of biographical data was available for each student, and all took Daniel's Figure Reasoning Test. This is a non-verbal mental ability test similar in some ways to Raven's Matrices. None of the sample had previously encountered this test. In addition, for 340 of the students, results were available for a series of standardized tests of Mental Ability, English and Mathematic. These are set by Prof. L.H.E. Reid and form the Common Entrance Examination through which students are selected to fill the available High School places.

Table 1: Distribution of Sample

Factor		Number of Students
SEX:		
	Male	252
	Female	334
AGES:		
	10	60
	11	194
	12	281
	13	51
SCHOOL TYPE:		
	Prep (3)	137
	Primary (5)	361
	All Age (2)	88
SCHOOL LOCATION:		
	Urban (3)	176
	Rural (7)	410
ABILITY:		
	High	79
	Medium	211
	Low	296
COMMON ENTRANCE GROUPS:		
Not entered		216
Entered, not considered		175
Entered, considered, no award		43
Awarded Free place		125
Results not traced		27
SOCIAL CLASS:		
	Upper	26
	Middle	400
	Lower	160

It was felt that attempting to establish the reliability of a Piagetian test of this nature was of rather dubious value since Sigel, Roeper, and Hooper (1966), Kingsley and Hall (1967) and Stafford (1969) had all reported investigations which, although showing the greater effects of training, also showed that children improved considerably when retested without training. It was expected therefore that there would be an improvement in the results of any group that was retested. Fifty two of the students were retested after a period of four weeks. In comparing the two sets of scores, a Pearson's r of 0.47 was obtained. Although significant ($p < .01$) this was not high enough to be regarded as a good measure of reliability and supports the contention that the test itself could be viewed as a learning experience. Further analysis of individual responses showed that 102 out of 364 responses on the retest indicated conservation which had not been shown previously. Details of this analysis appear in Table 2.

Table 2: Test-Retest Results

	Test	Retest
N	52	52
Mean	14.40	16.87
Standard deviation	3.08	2.02
Standard error	0.43	0.28
Difference of means	2.46	
"t"	4.78	
df	102	
Pearson's 'r'	0.47	
Significance	$p < .01$	

Further examination of the answers to the questions resulted in the following information. Out of 7 x 52 question areas:

46 answers went from non-conserving categories to the conserving category (0 and 1 → 3);

56 answers went from the part conserving category to the conserving category (2 → 3);

32 answers improved the score of non-conservers (0 → 1 or 0 → 2);

53 answers went from a higher to a lower score;

135 answers remained unchanged.

It appears therefore that 102 out of 364 question areas have had the effect of producing conservation where none existed previously, or that in some children the concepts have developed in the four weeks between the tests.

In order to determine whether the different concept areas are equally sensitive

to fluctuations the total number of answers which were the same, or had gone up or down, was extracted.

Table 3: Variation in Response on Retesting

Concept	N	Total up	Total down	Total different	Total same
Length	52	19	2	21	31
Area	52	27	4	31	21
Quantity	52	23	5	28	24
Weight	52	7	12	19	33
Internal Volume	52	19	10	29	27
Displaced Volume	52	17	10	27	25
Water Levels	52	18	10	28	24

From these figures it appears that the concepts of length and weight are slightly less susceptible to change, while area, quantity and water levels are slightly more susceptible to change.

Although the videotaped questions had been grouped into seven concept areas, it was intended that in four cases the questions would be measuring different aspects of the concept. In an attempt to determine whether this had been achieved, chi square was calculated for the responses to questions on each concept, comparing them in a 2x2 matrix. This was done for 10% of the sample chosen using a table of random numbers(1). The probability of a child getting each pair of items either both correct or both incorrect is very high if those items are measuring the same thing, As had been hoped, one question on area, one on weight and one on internal volume bore little relationship to the other questions on these concepts. It was interesting however that the results showed no distinction between displacement and deformation of length.

In constructing the videotaped test, it was assumed that items could legitimately be grouped together so that, although each conservation concept had, in effect, a subtest of 3 items, these subtests were similar in that they measured something not measured by mental ability or achievement tests. However, since the horizontal representation of water levels is an aspect of spatial ability, this subtest was not expected to be linked very strongly with the conservation items. Rather, in view of the strong link between spatial ability and sex that Mitchelmore (1974a and b) had found in Jamaica, a similar sex linkage was expected.

Factor analysis was performed on the data using part of the IBM Systems 360

(1) For questions 4 and 5 the whole sample was used, since 10% of it produced and empty cell.

Scientific Sub Routine Package. The rotated factor matrix is shown in Table 4. A cut-off weighting of .3 was accepted for the loadings on the factors.

Table 4: Rotated Factor Matrix: Complete Sample

No	VARIABLE	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
1	Sex	0.04125	0.01303	0.73211	0.10552
2	School Type	0.16009	0.02802	-0.02178	0.85737
3	Age	-0.56099	0.09134	0.24733	-0.06066
4	Location	0.53180	0.25481	0.05359	-0.25207
5	S.E.S.	-0.40602	-0.14776	0.25112	0.53593
6	C.E. Group	0.71259	0.10267	0.00290	0.15512
7	Non Verb. Test	0.78925	0.14217	-0.30819	0.13622
8	LHE Reid MA.	0.87795	0.13828	0.06641	0.15099
9	LHE Reid Math.	0.89583	0.14135	0.05323	0.11575
10	LHE Reid Eng.	0.88736	0.12055	0.08979	0.17228
11	Length	0.16120	0.65893	0.00658	0.20687
12	Area	0.12926	0.64131	0.04387	0.11670
13	Weight	0.12183	0.62220	-0.09459	-0.20551
14	Internal Volume	-0.00639	0.67021	-0.16509	0.01582
15	Displ. Volume	0.41316	0.33701	-0.19640	-0.11154
16	Water Levels	0.19796	0.23159	-0.70368	-0.00537

Factor 1 showed a very strong link between the non-verbal test and the three standardized tests with a weaker loading on social class and the location of the school. Displaced volume also was weakly loaded on this factor. Factor 2 linked together all the conservation concepts, but the loading of displaced volume was weak. Factor 3 linked the representation of water levels very strongly to sex, but with a very weak loading for the non-verbal test.

The factor analysis clearly demonstrated that the conservation items may be legitimately grouped to form a test which does not overlap to any great extent with mental ability or achievement tests. The expected link between sex and the ability to represent water levels was confirmed, and the expected distinction between the conservation concepts and water level representation was apparent. The connection between the displaced volume questions and the mental ability and achievement tests can perhaps be explained by the format of the answer sheet. The displaced volume answers were displayed in the form of a series of diagrams and were thus quite differently set out from the other answers. It is possible that the same ability is required both to interpret these diagrams and to do the non-verbal questions on the standardized tests. The low loading of displaced volume on Factor 2 would also point in this direction.

One final means by which the videotaped test could be validated, is by comparing the results achieved as a result of this test with clinically administered tests. Since the writer made no attempt to administer clinical tests, comparison can only be made with another researcher who was investigating the development of spatial ability in Jamaican children. A deliberate attempt was made to use three of the bottle positions that Mitchelmore was using. His results were reported (Mitchelmore 1974a and b) for students in Grades 5 and 7, for bottles held horizontally, tilted at 45° and held upside down. In each case the results of the videotaped test to Grade 6 students fall neatly between Mitchelmore's clinically obtained results, as can be seen in Table 5.

Table 5: Percentage of Students Correctly Representing Horizontality: Mitchelmore and Isaacs Results Combined

Concept	Grade 5	Grade 6	Grade 7
Horizontal Bottle	62.5%	67.2%	75%
Bottle Tilted at 45%	12.5%	31.5%	44%
Inverted Bottle	62.5%	65.3%	87.5%

It appears that the test constructed met the initial criteria listed, and that the analysis of the results shows that it was a valid method to use. It does eliminate much of the subjectivity involved in clinical testing by standardizing the procedure, while at the same time using materials and situations familiar to the student. In cases where an analysis of the thinking process used by individual students is not of prime importance, then this type of test can clearly be an advantage due both to its standardization and relevance, and to its economy of time, effort and material.

BIBLIOGRAPHY

1. KINGSLEY, R. C. and V.C. Hall; Training conservation through the use of Learning Sets, in *Child Development*, 1967, 38, pp 1111–1126.

2. LLOYD, Barbara B.; *Perception and Cognition: a cross-cultural perspective.* Harmondsworth, England; Penguin 1972.

3. MITCHELMORE, M. C.: A development study of the spatial ability of Jamaican students. Mico College, Kingston, Jamaica. 1974(a) Cyclostyled.

4. ————: The perceptual development of Jamaican students. Ohio State University. Unpublished Ph.D. Thesis,

5. MURRAY, Frank B.: Stimulus mode and the conservation of weight and number. *Journal of Educational Psychology*, 1970, Vol, 61, No. 4, pp 287–291.

6. O'BRYAN, K and F. Boersma, F.; Movie Presentation of Piagetian tasks: a procedure for the assessment of Conservation attainment, in *Journal of Genetic Psychology*, 1972, 12, pp 295–302.

7. SAMUDA, Ronald J.: *Psychological Testing of American Minorities: Issues and Consequences.* New York, Dodd Mead and Co., 1975.

8. SIGEL, I. E., A. Roeper and F. H. Hooper; A training procedure for acquisition of Piaget's conservation of quantity: A pilot study and its replication, in *British Journal of Educational Psychology*, 1966, 36, pp 301–311.

9. SINGH, Balwant: The development and analysis of objective group tests based on Piaget's tasks. Unpublished D.Ed. Thesis, University of Toronto 1968.

10. STAFFORD, D. G.: The influence of the first grade programme of the Science Curriculum Improvement Study on the rate of attainment of conservation. Unpublished Ph.D. Thesis, University of Oaklahoma, 1969.

11. TEATES, T. G.: A comparison of the performance of ISCS and non-ISCS 9th Grade Science students on several Piagetian tasks. Unpublished Ph.D. Thesis, Florida State University, 1970.

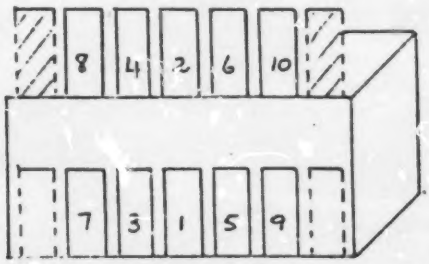
12. WHEATLEY, G. H: Socio-economic status and mode of presentation as factors in Children's Concept Attainment, in *Journal of Experimental Education*, Summer 1975, Vol. 43, No. 4, pp. 6–14.

APPENDIX 1

Piagetian Test

Number Concepts: Practice Questions, not scored: E1, E2, E3.

Two of the girls were seen unpacking a box of drinking glasses prior to washing them. They decide to see how many they have and put them in two rows in the following order, the top row standing on the box and the bottom row standing against it:



The letter A was placed by one row and B by the other, and the question was asked: "Are there as many glasses in A as in B." A blow-up of the answer sheet was shown and the three possible answers stated, a moveable tick being placed in the correct place for each answer. "If A has more, tick A; if B has more, tick B; if they have the same number of glasses tick S. S stands for Same." One girl then stated that she could make more in her row.

Glasses 7 and 9 were then moved out to occupy the dotted spaces, 3 and 5 being moved a little so that the row was evenly spaced. The question was repeated; the method of recording the answer was again demonstrated. The second girl said that she could make her row have as many.

Two glasses were added to the top row in the hatched space. Equality was questioned and method of answering demonstrated.

Conservation of Length

Q.1 Two girls seated at a table discussing the wedding are joined by a third who asks them to help her sort out some hair ribbons for the little ones to wear.

They take out two of equal length and lay them on the table with their ends level, saying these will do for Jane and Mary. One girl remarks that Mary's hair is long so she will need a longer ribbon. She then declares that she can make one ribbon longer, and moves one of them a little to the right.

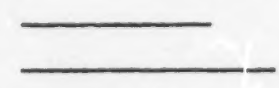
"There, now it is longer."
"No," replies the second girl, "this one is longer" - pointing to the one that has not been moved.
"You are both wrong," says the third girls, "they are both the same length."

Question: "What do you think?" A and B are placed by the two ribbons. "If A is longer, tick A; if B is longer, tick B; if they are the same, tick S for Same."

Q.2 The ribbons were put back to the first position and then Girl 2 suggested that if Jane needs a shorter ribbon she can make one of them shorter. This she does by making it into an S, while keeping one end stationary.

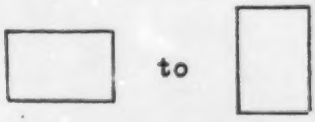
The other two girls express their opinions, and the question is asked of the children as before, but with the responses in the order B, S then A.

Q.3 The two original ribbons are put to one side and two more removed, matching in colour but not in length. They are placed on the table. These are needed for a child who need a matching pair. Girl 3 declares that she can make them the same length and forms them so that all the ends are level. The other girls express their opinions and the question is posed as before. The rest of the questions follow this pattern.

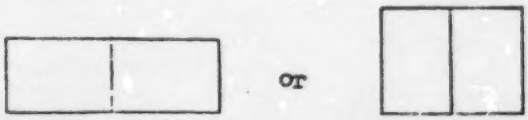


Conservation of Area. Q4, 5 and 6

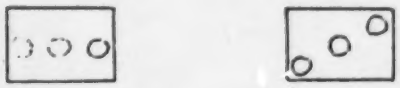
Q.4 This involved two matching small tables (flat-topped school desks). In question 4 they were being polished, one girl turning hers round from



on the grounds that she would use less polish that way. In question 5 they discuss which arrangement will give most space when the tables are put together,



In question 6 they placed two identical mats on the two tables and placed three identical bottles on each mat, arranging them as follows:



They then discuss which mat has most space left for putting glasses on.

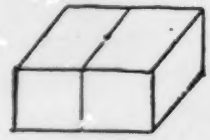
Conservation of Quantity. Q.7, 8 and 9

Here the girls were making pies. Their pastry is made and they divide it into two balls which they adjust until they are equal. One ball is then formed into a wide flat roll and the question (7) is posed as to whether there is as much pastry in the roll as in the ball. Then the roll was flattened into a dumpling and the question (8) was repeated. Finally the dumpling was rolled out with a rolling pin and the question posed for the last time (9).

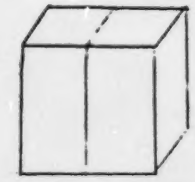
Conservation of Weight. Q.10, 11 and 12

Here the girls have a balance and a block of butter and a block of cheese which are exactly the same size. No mention is made as to what the blocks are composed of, but the girls wonder if they would weigh the

same if they put them on the balance. The children are asked what they think (Q.10). The butter is then put in the refrigerator and the cheese is cut into 2 pieces which are placed on the balance. Having established that they weigh the same the two pieces of cheese are put onto 2 separate plates. They comment that there does not seem to be much cheese, and one girls says she can make hers weigh more and cuts one piece of cheese into several pieces. They comment, and then the question (11) is posed. The cheese is then put away and two packs of margarine are taken, each containing two slabs. Two slabs of margarine are placed on each balance pan and their equality established. The slabs from one pan are then stood upright on a plate while the other blocks are cut in two pieces and placed on a different plate:



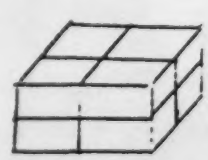
and



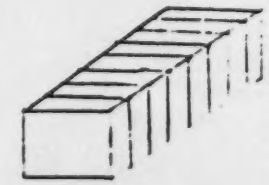
Again the girls state the possible answers and the question (12) is posed as to whether or not the two lots of margarine still weigh the same.

Conservation of Volume - internal. Q.13, 14 and 15

Here we see two of the girls having gone to fetch the milk. We watch as an ordinary quart bottle is filled from a bucket of milk. The milk is then poured from the quart bottle into an imperial quart bottle and the quart bottle is refilled. They discuss which bottle contains more milk and the question (13) is posed as before. They then go home and, arriving thirsty ask for a drink. They watch as another girl fills a small jug with Koolaid and pours it into a tall narrow glass. She refills the jug and pours it into a shorter wider glass. They discuss which glass has most and the question (14) is posed. While drinking they find a pile of 16 empty Jello boxes and divide them equally between them. They stack them differently:



and



They then comment that they each need one box to hold all the smaller ones and discuss whether two such boxes would have the same amount of space inside. The question (15) asks the children what they think.

Conservation of Volume: displaced. Q.16, 17 and 18

One girl is seen washing a straight sided, cylindrical glass jug with soap and water. The jug is seen two-thirds full of water and with the soap at the bottom of the water. The girl puts her hand in the jug to get out the soap but does not succeed and repeats the action, retrieving the soap. The rise in the water level is thus displayed. She then holds the soap over the top of the jug in this position and the girls wonder what would happen to the water if she put the soap in this way. The answers to this question were shown as a series of diagrams. D1 showed the jug with the water but no soap, D2, D3 and D4 showed the jug with the soap at the bottom, in the position, but the level of the water was shown as lower than the original (D1), the same level as D1 and higher than D1. The children were asked to tick which drawing they thought showed what would happen (Q.16). The girl then held the soap in the position and the question (Q.17) followed as before. Then the girls speculated as to what would happen to the water if the soap was cut up into bits and all the bits were dropped in. The question (18) was asked.

Horizontality: Water Level Tests. Q.19, 20 and 21

These three questions did not involve the girls. The film showed a bottle half full of coloured water and the attention of the children was drawn to a similar one drawn on their answer sheets. They were then told that the other 3 drawings on the sheet showed the bottle tilted "Like this... (bottle tilted to 45° and held there for 25 seconds); like this...(bottle

placed horizontally for 25 seconds) and like this...(bottle placed upside down and held there for 25 seconds, then returned to its original upright position). The children were then asked to use their pencils and draw the top of the water in each bottle and to shade it so that we could see where the coloured water was.